## LXII.—*On* Hyalonema lusitanicum, *and on the Animal or Vegetable Nature of Sponges.* By Professor Ehrenberg*.

That the glass-plant (*Hyalonema Sieboldii*), which had been previously regarded as a polype with a siliceous axis, is only an artificial product of Japanese industry, the siliceous axis of which has been brought into an unnatural union with foreign substances, including polypes and sponges, by means of thread and wire, was stated by me in 1860 and 1861, as is published in the 'Monatsberichten' of those years. The true origin of siliceous axes resembling threads of glass as evidently concentric organic structures was then inexplicable.

In the year 1864 Professor Barboza du Bocage, of Lisbon, described, in the 'Proceedings of the Zoological Society of London,' a new species of the interesting glass-plants from the European seas off Portugal; but its habitat was not then quite certain. As the point whether these are polypes with a siliceous axis appears to me to be of essential significance for the physiological conception of systematic zoology, I regard this subject as not unworthy of being mentioned again to the Academy. The locality of the so-called *Hyalonema lusitanicum*, which was founded upon a single specimen, was still doubtful in 1864; but, according to a more recent notice by the same naturalist in the same journal (Proc. Zool. Soc. 1865, p. 662), it has been established with certainty by the discovery of new examples. Besides the first specimen, the Museum at Lisbon now possesses two others, likewise obtained from Setubal, and also numerous isolated siliceous filaments, which appear to belong to three or four different individuals. The two perfect specimens are 17 and 29 inches in length, and the largest is very beautifully preserved. The discoverer says that in the best-preserved, largest, and most perfect specimen a skin (corium) completely envelopes the axis. He now thinks that this form is established not only systematically, but also as belonging to the Portuguese seas, and that it is not even rare. The superstitious fishermen know it very well; they call it *Cravache de la Mer* (Sea-whip), and when it makes its appearance they fear bad success in their fishing. It is found in the apparatus used in the Dogfish fishery, and is immediately torn to pieces and thrown into the sea by the fishermen.

As regards the nature of this body, Professor Barboza du Bocage does not share the opinion of those naturalists who regard the Japanese form as the production of a sponge, but takes part with those who consider it a polype. On no specimen of

* Translated from the 'Monatsbericht der Berliner Akad. der Wissenschaften,' December 1866, pp. 823–837, by W. S. Dallas, F.L.S. &c.

the Portuguese form does there exist a sponge-mass like that of the Japanese. The *corium polypigerum* in the Portuguese specimens completely covers the whole of the thin end and three-fifths of the axis. The polype-structures occurring at the extremity of the axis are the smallest. The corium and the polypes are formed of several superposed layers of tissue, in which there is a very great quantity of siliceous spicules, which have different forms in the different layers. The shagreened and granular surface of the corium is not a sandy incrustation as in the polypes from Japan, but it is caused by regular clavate siliceous spicules, which are spinous all over (*Spongolithis clavus*, Ehrenb. Monatsb. Berl. Akad. 1861). These clavate spinous spicules form an essential part of the external skin or covering. Each tube, regarded as a polype, is supported by a border of fine siliceous spicules, which are deposited in a longitudinal direction and at equal distances in the inner wall of the body-cavity.

From these very meritorious communications of Professor Barboza, it appears most distinctly that the body more than 2 feet in length occurring near Setubal in the Portuguese sea certainly answers the question relating to *Hyalonema*, whether it be a polype or a sponge, in favour of the latter view.

The long filiform siliceous spicules which, forming a bundle, constitute the axis, are certainly the middle portion of a sponge. This sponge, the structure of which is described in detail by M. Barboza du Bocage as consisting of smaller siliceous spicules, and the numerous orifices of which he regards as the apertures of polypes, covers, as was to be expected, the thin end of the fasciculated siliceous filaments of the axis up to the apex, where, moreover, the above-mentioned efferent apertures (?) are smaller than on the middle and lower part of the body; so that in a *sound state* there exists neither a short nor a long tuft of freely projecting siliceous threads. The lower part, which, according to M. Barboza, amounts to two-fifths of the whole length, is therefore free, probably, however, only in consequence of injury in tearing the object away from a firm basal piece, which may perhaps be exactly like that of the upper part. It therefore appears indubitable that the thicker part of all known similar siliceous filaments is the lower part, and the thinner the upper. Consequently the comparison of certain natural orifices in the corium with polypes appears to be not sufficiently well founded. The observer has seen either parasitic polypes, or merely orifices such as occur so frequently in sponges. Moreover the structure of the so-called corium is completely different from that of the parasitic polype-corium of the Japanese stems, which certainly contains demonstrable antho-

zoarian polypes (as was shown even by Brandt), and which bear no sponge-spicules, but only sea-sand, in their skin, as I proved in 1860. The great difference between the Japanese *Hyalonemata* and the Portuguese ones is, that the Japanese axial bundles are artificially twisted, and compelled to remain in this form by means of thread and wire. Moreover the Japanese siliceous filaments, having been torn from their natural connexion, are sometimes put together again in a reversed position, and nearly always the entire direction of the axial bundle in relation to the sponge covering it at one end is reversed. The superior, natural sponge, which produces the axis, has been stripped off and thrown away, and a new foreign sponge has been allowed to grow, or been fastened upon the thicker end.

By these new Portuguese observations, therefore, the subject is, in my opinion, settled, and the forms of *Hyalonema* can certainly no longer be described as anthozoarian polypes; whilst the origin of their siliceous axial threads has also found a satisfactory explanation; but neither can they be regarded as sponges furnished with a projecting siliceous tuft. Moreover there can now be no doubt that the Phytolitharia, hitherto known almost exclusively as microscopic corpuscles, will certainly by these observations be enriched with Spongolithes of from 1 to $2\frac{1}{2}$ feet in length, which may be designated hereafter as *Spongolithis vaginata Hyalonematum* when they occur isolated, without their sponge, in the sea-bottom, or as fossils in rocks.

The notion which has lately been often expressed, that there are sponges with frequently long, protruding tufts of filaments of a siliceous axis at their apex, appears now to be due to mutilation, often brought about naturally, in the same way as in the cortical polypes with horny axes, which may not unfrequently be raised fresh from the sea with dead horny points from which the living polype-bark has been stripped off, and even with the basal portion of the stem destitute of bark. In the same way the spongy coat of the apices of *Hyalonemata* and of their bases may sometimes be lost, even in the sea, whilst the rest of the covering continues to vegetate; for it is organically inconceivable that naked siliceous threads without a cellular envelope should grow out freely from within.

As regards the question whether these sponges themselves are animals or plants, and whether, little as they are comparable with the true polypes of the Anthozoa, they might be named polypidoms in a much simpler series of forms, as, indeed, is indicated by my former representations from Bacillarian and even Monadic stocks, I see no inducement at present to give up the opinion, already repeatedly expressed by me, that the Sponges cannot be described as animals. It is true that the most recent

and very meritorious German systematic student of sponges has adopted the opinion of those who regard the marine sponges as animals; and the beautiful observations upon the motile young of the *Spongillæ*, as well as the demonstrated filling of many tubes in the horny sponges with fine sea-sand, in which there are Polythalamia and *Bacillariæ*, appear to many naturalists to be sufficient proofs that the reception of solid nutriment into the interior of the body of these organisms really takes place. The cilia and fine motile filaments observed here and there upon sponges strengthen these arguments. But neither the ciliary organs, which also occur on the swarm-spores of plants, nor the tubes, nor the anti-vital (*lebenswidrige*) filling of the tubes of many horny sponges with sand, evidently after their death, appear to me sufficient to prove the animal organization of these objects.

Hitherto we have no observation of the primary character of all true animals, the limitation of an individual, which is unmistakeable in all true polypes, and is distinct even where the individual forms are intermixed and coalescent below, as in the *Ascidia composita*, *Sertularinæ*, *Halcyonellæ*, and many similar forms. Separate individuality, the reception of solid nutriment through a mouth into internal spaces, very different from tube-currents through cellular tissues, as also frequently quite distinct muscular substance for contractions, very different from contractile tissues, as demonstrated by me and others in *Vorticellinæ*, *Stentorinæ* (confirmed in 1857 by Lieberkühn), *Carchesium*, *Opercularia*, and most strikingly in the Rotatoria and many similar animals, are characters still undetected in sponges, and which separate animals from plants. Nay, in microscopic animals, as so distinctly in the Crustacean *Cyclopidæ* and many others, the eye-spots may not unfrequently directly indicate a nervous system, the colourless transparency of which may often cause it to appear to be wanting. Even in *Ophryoglena flavicans* a confirmatory greater complication was indicated by Dr. Wagner in 1856. Undoubtedly it must be pointed out that the most recent and best observers constantly discover new conditions of organization—*i. e.* greater compositeness, which is quite in opposition to the notion of unicellularity, but not suited to disprove animal organization.

In the elucidation of the question whether the Sponges may be regarded as polypoid animals of a low grade of organization, which have been named sometimes Protozoa, sometimes Zoidia, sometimes Amorphozoa, and so forth, we must not pass over the fact that of late there has seemed to be more to justify our regarding the bodies lying in the interior of these structures near the base as ova, especially as their development into perfect swarming young has been carefully traced, and even spermatozoid-

capsules have been detected. But, nevertheless, no one has yet succeeded in proving either a tube-relation or a body-relation of an individual animal towards these bodies as ova.

Matters are very different in the case of the true animal-stocks of the *Ascidia composita* and of *Halcyonella stagnorum*, which are often very like a *Spongia* or *Spongilla*. Here we have numerous separate individual animals, each in its separate tube, and united into a mass, and the very numerous ova occurring at the bottom of these may be recognized as belonging to individual animals, just as those Rotatoria which bear tubes deposit their ova in the bottom of the tubes.

As, therefore, a polypoid individuality could never be detected in sponges—as, also, the granules regarded as ova occur only in the interior of the base—and as, further, the tubes of all sponges (and I have examined them myself repeatedly in the fresh state in various seas) are always open empty canals which allow the currents of water produced by ciliary action to flow to and fro freely,—the greater part of these bodies appears rather to be a plant-like cellular structure, the basal fruit-production of which (and this is not known in all) has its still indistinct analogue in that of many different Algæ only now beginning to be elucidated, and perhaps even in the *Rhizocarpeæ*.

Even in the true *Rhizocarpeæ* the conditions of structure have only been very recently elucidated; and as to their developmental conditions a somewhat satisfactory result has only been quite recently arrived at, as in the case of many Algæ, of which, however, many forms still require further investigation. The swarming young of the *Spongiaceæ* do not differ from those of the *Vaucheriæ* and *Saprolegniæ*: these were observed by Unger in 1827 in green *Vaucheriæ*, but long before him, in 1745, by Gruithuisen and Needham in Algæ; and upon their very different character from Infusoria, leaving all ciliary movement out of the question, I have given a very detailed historical and physiological critique in my 'Infusionsthiere' (1838, p. 37). In what way the segmentation (cell-formation?) of the supposed ova of the *Spongillæ* is to be interpreted must be left to further investigation to determine.

Moreover, according as we suppose the Sponge to be an animal or a vegetable body, the question of its nutriment must be affected in opposite ways. If the Sponges be animals, their nourishment must be conveyed from in front and without, through apertures capable of being closed; if they be plants, the nourishment must be supposed to pass from the root-like base outwards and forwards by endosmose and exosmose (diffusion). Artificial siliceous nourishment presented to the base alone in elongated *Spongillæ* may perhaps decide this point.

It has always struck me as very remarkable that in the many investigations of the largest and smallest forms of life which I have carried on under multifarious and favourable conditions, I have never met with an animal with a constantly open mouth and digestive cavity; whilst in the Sponges, both of the sea and of fresh water, I could find nothing but constantly open tubes, which never closed even periodically or under the influence of irritation. Nay, I have always found a physiological impossibility in the notion that a tube with no obstacle to the access and change of water, even when clothed with a ciliary coat, can furnish any assistance to zoochemical assimilation or digestion. Decomposable matters may certainly become putrid and soluble in water in them, and be thrown out again; but a constant change of water will not bring even this to assimilation. On the other hand, the periodically and voluntarily closable mouth of animals is usually aided by a second closure, which is to be characterized as the œsophagus, and is retained by nature in a very remarkable manner even down to the smallest forms of animals, by which means the quiet segregation of the materials conveyed into the interior of the body for assimilation is greatly favoured. The observations so carefully made since the year 1856 by Lieberkühn and Wagner upon the organization and reproduction of the *Spongillæ* certainly furnish many characters which seem to be in favour of their animal nature; and these have also quite recently been recognized by Van Beneden*, as also by Häckel, as animal characters. But the great irregularity of this organism, which is also frequently formed by the fusion of several individuals, and the slight filling of its so-called nutritive cells with recognizable materials even during very rapid growth, appear to me to have not yet admitted a satisfactory solution of the mystery. It is true the large open tubes of the *Spongillæ* are the more shown not to be polype-bodies; but the essential character of all animals known to me is remarkably wanting—namely, the individual separation of a single organism, which constantly occurs in animals, and is as constantly wanting in plants. I have never been able to obtain accumulations of indigo or carmine in *Spongillæ* and sponges, either in tubes or in round cells, in the way so distinctly presented by even the smallest of true animals; and the deposits of indigo noticed by the above-mentioned observers are clearly not regular aggregations, and are only so represented even by them. I must here not allow the fact to pass unnoticed that I always expect to find œsophagoid contractile organs behind the mouth in all animals: these, in the Poly-

* Recherches sur la Faune littorale de Belgique, Polypes, 1866, (Mém. Acad. Belg. tome xxxvi.) p. 198.

gastres, by their multiple repetition form the segmented nutritive apparatus.

In connexion with the beautiful observations upon the development of the siliceous spicules, even in swarming spores, the inquiry as to the possibility of such inception of silica from the water becomes still more pressing, although in glass vessels it may readily be explained from the glass.

These siliceous spicules present another character, which this is the place to mention. They have no corresponding analogy in the elements of the animal body, but have a great analogy in those elementary parts of plants which, as fusiform, thick-walled liber-tubes, belong to the prosenchyma, and also, sometimes, like the siliceous threads of *Hyalonema*, become several feet in length. These thick-walled liber-tubes of plants consist of separate short cells, and, according to the most recent investigations *, sometimes contain milky juice in their median canal. They are variously formed—sometimes (distinctly in *Cannabis*) digitated at the extremities and variously united in the middle, always cylindical, sometimes knotted with pore-canals. The spongolithes are also cylindrical, also frequently divided at the extremities, and variously furnished with verticillate branches or anchor-like †. Many are, like twin-crystals, crossed either obliquely or at a right angle, like staurolith; many are glandiform, globular, with or without conical points, comparable to the frequently stellate hairs of plants (stellate hairs in the interior of the stem of *Nymphæa* and on the surfaces of some leaves), but very rarely to animal cells; all are, therefore, morpholithes in the sense ascribed by me to that term in the last plate in my 'Mikrogeologie,' 1854. Frequently the surfaces of the fusiform spicules are perforated (pore-canals) and present canals passing perpendicularly to a constantly present median tube (*Spongolithis foraminosa* and *S. fistulosa* ‡, *S. porocyclia* § and *S. porosa*‖. In the Spongolithes also there is never air in these tubes during life, as may be learnt from the fact that under the microscope they do not appear as black streaks, but colourless and difficult to make out, whilst in dead Spongolithes in water this blackness is distinct. When alive they are consequently filled with a colourless juice. Nodose Spongolithes also are not uncommon (*S. mesogongyla*¶, *S. nodosa*, *nodulosa***, and *monile*††, *S. tracheogongyla* ‡‡ and *S. philippensis*).

* Schacht, Prüfung der Gewebe, 1853; Milchsaftsgefässe, 1856. Hanstein in his prize essay on the "Milchsaftsgefässe," 1864.

† Schacht, 1853, Hanffaser, taf. vi. fig. 4 *b*.

‡ Mikrogeologie, taf. xvi. fig. 118 ss. *furcata*, and fig. 119.

§ Monatsbericht, 1861.

‖ *Ibid.* 1845.

¶ Mikrogeol., taf. xvii.

** Monatsbericht, 1855, 1861.

†† Mikrogeol. taf. xxxiv.

‡‡ Monatsbericht, 1856.

The whole of these Spongolithes are, indeed, most like isolated, variously entangled tubular cells; but in *Hyalonema* they acquire the perfect character of long connected liber-tubes.

Quite different is the behaviour of the calcareous parts of the Radiata and Anthozoarian Polypes, which, although often fusiform, have no canal, and are frequently net-like and variable in form. All these, named Zoolitharia by me in 1841, remind us of the first isolated developments of the bones, shells, and hard cutaneous parts of animals, the aggregations of which are solid and (because like calcareous sinter) doubly refractive. Even the anchor-like organs of the skin of many Echinodermata (*Synapta*) are seated upon reticulated calcareous plates, and are articulated in the manner of the spines of the sea-urchins (*Cidaris*) ; they have consequently, except in form, no relation to the anchors of the *Spongillæ*. They are calcareous setæ with barbs.

*Summary.*

1. Thus the Portuguese *Hyalonema* is not a Polype, but a Sponge.

2. The Sponges themselves are without those decisive characters of independent animal bodies which have been detected down to the smallest monads.

3. The essential characters of the Sponges coincide without difficulty with those of vegetable structure, inasmuch as their supposed animal characters, automatic ciliary movement, swarming young and spermatozoids, and some contractility, as also a movement of the juices, have been recognized in both kingdoms.

4. The siliceous parts of the Sponges, or Spongolithes, appear to have a great analogy to usually innumerably isolated, smooth, juice-bearing vascular cells, like the thick-walled liber-cells of plants, with which they coincide also in the most various forms, but to have no similarity to any structures in the animal body,—in the *Hyalonema*-threads even resembling internal liber-tubes of two feet long.

5. The supposed normally protruding tufts of *Hyalonema* appear, when they occur on true sponge-structures, to be mutilations by the loss of the apices of these sponges, like the dead points of the horny corals, just as the deciduous trees in the north or on elevations often bear antler-like dead summits whilst the trunk is still well furnished with foliage.

6. The *Euplectellæ*, described by Owen in the years 1841 and 1857 as *E. aspergillum* and *E. cucumer*, the latter from the Seychelles, and the former from the Philippine Islands, exhibited to their very meritorious discoverer, who only saw them in a dry state, a gelatinous interstitial mass, but no trace of

animal character. Thin threads, several inches in length, united into a complex network, which, in *E. aspergillum* are expressly described as horny and not siliceous, do not form a protruding tuft, but are rather external bent hairs, free only at the base. How far these external filaments of the *Euplectellæ*, which are very like those of *Hyalonema*, likewise resemble tubular cells I cannot say from my own inspection, as these very rare bodies were never accessible to me for examination. But undoubtedly I can detect no character of animal organization in the description, inasmuch as gelatinous interstitial parts occur also in large Fungi and Algæ (*Myxomycetæ*, *Tremellæ*, *Ulvæ*, and *Fuci*, the latter often edible in consequence of the amount of mucus and jelly they contain). It is also to be observed that in England no near relation was noticed between *Euplectella* and *Hyalomena*, although the latter had been in the British Museum since 1835, and Valenciennes in 1850 had already referred *Hyalomena* to the sponges; it then, as at present, was everywhere placed as a polype in the zoological museums.

7. The penetrating ammoniacal odour of the sponges occurs also in living *Characeæ* and dead *Fucoideæ*.

8. Another portion of the Phytolitharia are fillings up of variously formed vegetable cells analogous to woody deposits, or siliceous membranes, all without double refraction.

9. The Zoolitharia are isolated and often tubercular calcareous parts of a discontinuous, complete or partial, framework in the Echinodermata and other Radiata, the Corals, and many other forms, without any vasculiform character and with double refraction.

10. The animaliform *Bacillariæ* furnished with openings, incepting indigo, and creeping, are essentially different in the formation of their siliceous shells from the siliceous cells of plants.

11. It is probable that the great deposits of silica in these plants are only effected by means of the flow through them of extremely large quantities of water containing but little silica.

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## LXIII.—*Remarks on the River-Fishes of Chili.* By Dr. R. Philippi, Director of the Mus. of Nat. Hist. at Santiago in Chili*.

Although we may affirm in general terms that Chili is poor in freshwater fishes, the number of these which it actually possesses is much more considerable than has hitherto been supposed. In Gay's work the only Percoid given is *Perca trucha*,

* Translated from the 'Monatsbericht der Berliner Akademie' for November 1866, by Arthur W. E. O'Shaughnessy.